



VERGE AERO

Design Studio Software Manual



Verge Aero™ Design Studio Software Manual

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All product information and specifications mentioned in this document are subject to change.

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Note: Because Verge Aero frequently releases new versions and updates to its system software, applications, and Internet sites, images shown in this manual may differ slightly from what you see on your screen.

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# Introduction

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Welcome to the exciting world of drone shows!

We have designed this application to make it possible to design a drone show without the need for specialized knowledge. Although there are sophisticated features within the application that require more training, we've tried to make easy things easy to do.

We welcome your feedback. If you have any suggestions for how we can make this software better, please let us know by sending a note to [support@vergeaero.com](mailto:support@vergeaero.com).

Before we begin, just a quick note on conventions used in this document.

Anything you have to *click* is in italics.

Everything is a left-click unless otherwise specified.

Timeline events are indicated in [brackets].

# Quick-Start Guide

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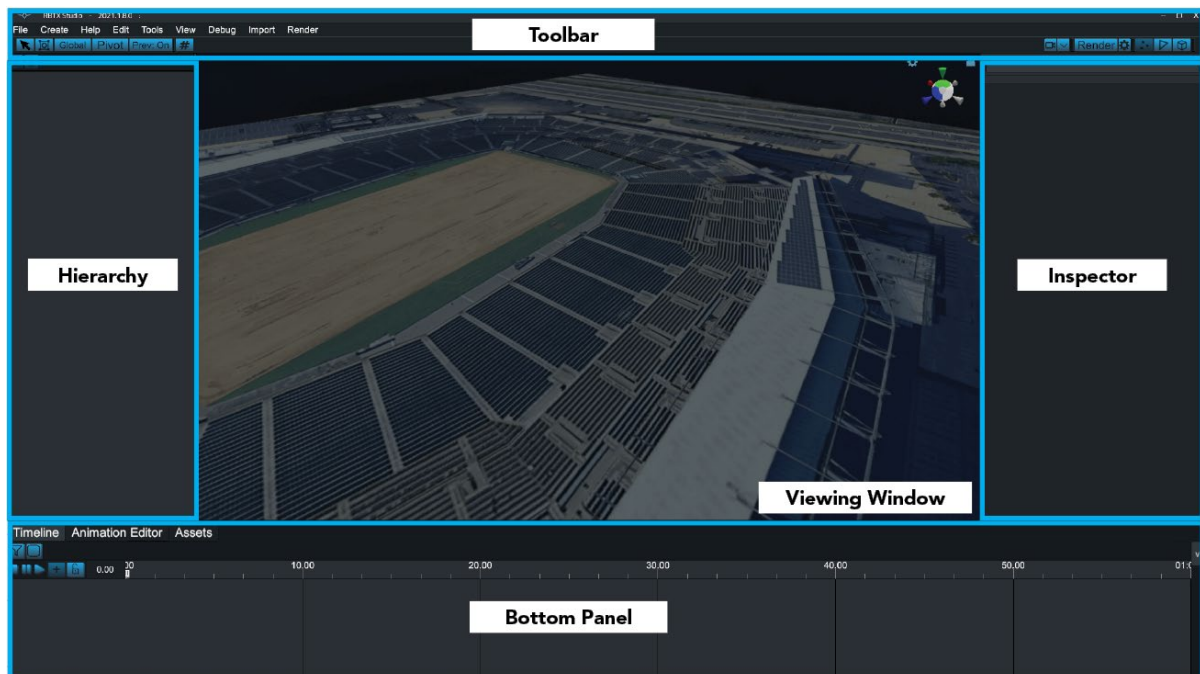
In the Quick-Start Guide you will follow step-by-step instructions to learn the basics of Verge's Show Designer and create a sample show. You will learn how to select the number of drones in your launchpad, add shapes to the scene, and assign the drones to those shapes. You will learn how to add lighting events and transform events and finish with rendering your show.

Please note that it is important to read all the information in step 1 to follow the rest of the instructions easily. Further background information is provided in the Essential Knowledge section of the manual.

## 1. Create a New Show

- a. Launch the software.
- b. In the bottom right of the Projects dialogue box select *Create*.

You are now in the default outdoor show environment.



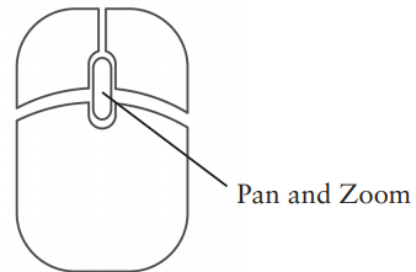
The **Toolbar** contains menus and buttons allowing you to edit the environment, add preset shapes, render your show, and get help among many other options.

The **Hierarchy** displays any object that is in the scene. This includes the launchpad, individual shapes, formation groups, cameras, etc. Collectively these items within the Hierarchy are called objects. When an object is selected in the Hierarchy it will be highlighted blue. Any time an object is mentioned in this guide you will be able to find it in the Hierarchy.

The **Bottom Panel** holds the Timeline tab which contains all the show's timeline layers and events, and the Assets tab which contains folders for custom shapes and sequences. Any time an event or layer is mentioned in this guide you will be able to find it in the Timeline tab. Timeline navigation controls are shown below.

### Timeline Navigation

Center-click and hold to pan the timeline.  
Scroll with the wheel to zoom in and out.

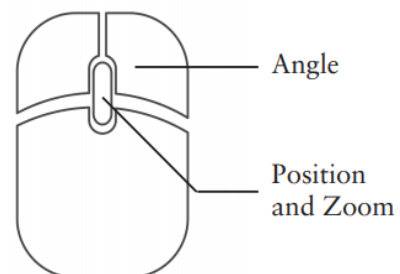


The **Inspector** displays the properties of objects and events. These properties are manipulated and fine-tuned by the user to produce the desired show. The Inspector displays the properties of whichever item is currently selected.

The **Viewing Window** is the 3D space where shows are created. This space inside the window is called the scene. Viewing window navigation controls are shown below.

### Viewing Window Navigation

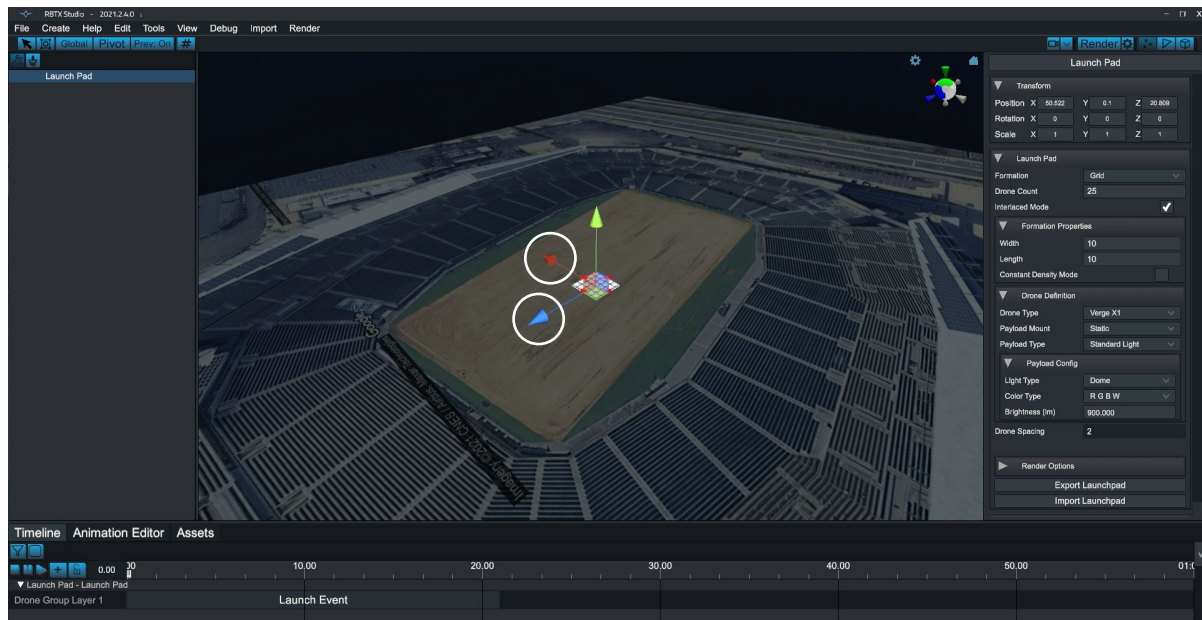
Right-click and hold to change viewing angle.  
Center-click and hold to change viewing position.  
Scroll with the wheel to change viewing zoom.



## 2. Create Launchpad

- From the Toolbar select *Create > Swarm Control > LaunchPad*.
- With the Launchpad object selected in the Hierarchy, navigate to the Viewing Window and use the red and blue position handles to drag the launchpad to the center of the stadium.

Note: A Drone Group Layer has been created in the Bottom Panel and contains a [Launch Event].



Launchpad object selected in Hierarchy. Launch Event in the Timeline. Red and blue position handles circled.

### 3. Add Drones to Launchpad

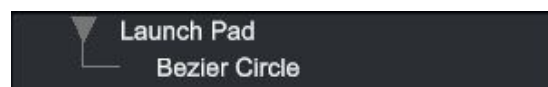
- With the Launchpad object selected, navigate to the Inspector and change the Width from 10 to 15 and Length from 10 to 15.
- In the Inspector change Drone Count from 25 to 50.

### 4. Import and Orient a Circle Shape

- In the Toolbar select *Create > Shape > 2D > Circle*.
- In the Hierarchy drag the Circle object into the Launch Pad object. Placing an object within another object is called nesting.

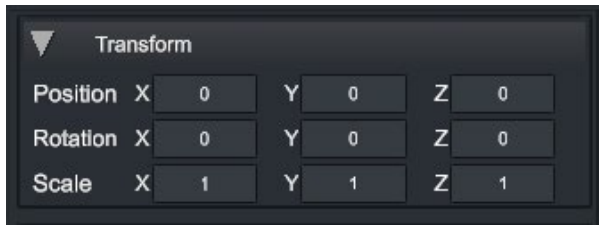


No nested objects.



Circle object nested within the Launchpad.

- With the Circle object selected in the Hierarchy, navigate to the Inspector and right-click *Position* in the transform box. This will set the circle's position fields to 0 and center it on the Launchpad. When an object is nested its orientation is relative to the object it is nested in.



Transform box found at the top of the Inspector. Right click on the word “Position” to set all position fields to 0.

d. Make the following transformations to the Circle in the transform fields of the Inspector to give the Circle some altitude and increase its size.

Position Y: 0 to 50

Rotation X: 0 to 90

Scale X: 1 to 30

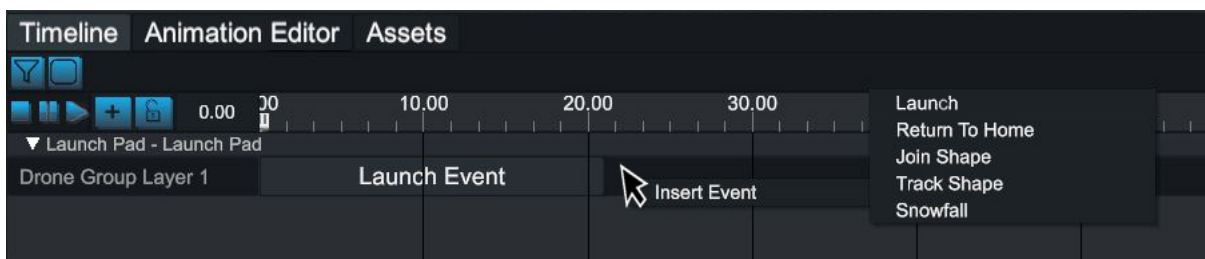
Scale Y: 1 to 30

Scale Z: 1 to 30

## 5. Join Drones to Circle

Reminder: To zoom in and out of the timeline, hover your mouse over the timeline numbers and scroll with your mouse wheel.

a. With the Launchpad object selected in the Hierarchy, navigate to the Bottom Panel and right-click next to the [Launch Event] on the Drone Group Layer. Select *Insert Event > Join Shape*.



To add an event in the Drone Group Layer, right-click on any free space in the layer.

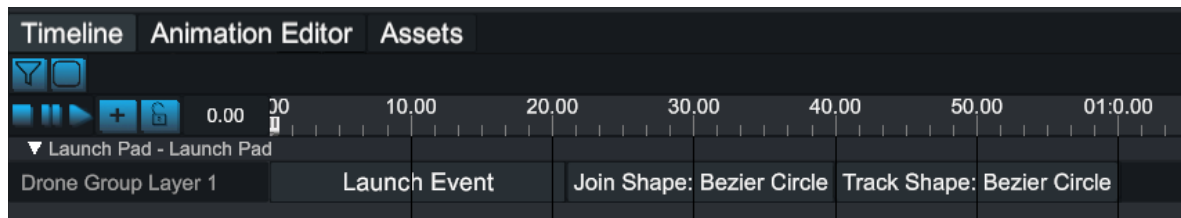
b. Move [Join Shape] left to meet [Launch Event] and drag to extend it to 40.00.

c. With the [Join Shape] event selected, navigate to the Inspector and click the Target Shape dropdown. Change “Empty” to “Circle” to assign the drones to join the Circle.



## 6. Track Drones on Circle

- With the Launchpad object selected, navigate to the Bottom Panel and right-click in the Drone Group Layer and select *Insert Event > Track Shape*.
- Move [Track Shape] left to meet the [Join Shape] and drag to extend it to 01:00:00.
- With the [Track Shape] event selected, navigate to the Inspector and click the Target Shape dropdown. Change “Empty” to “Circle” to assign the drones to track the Circle for the duration of the event.

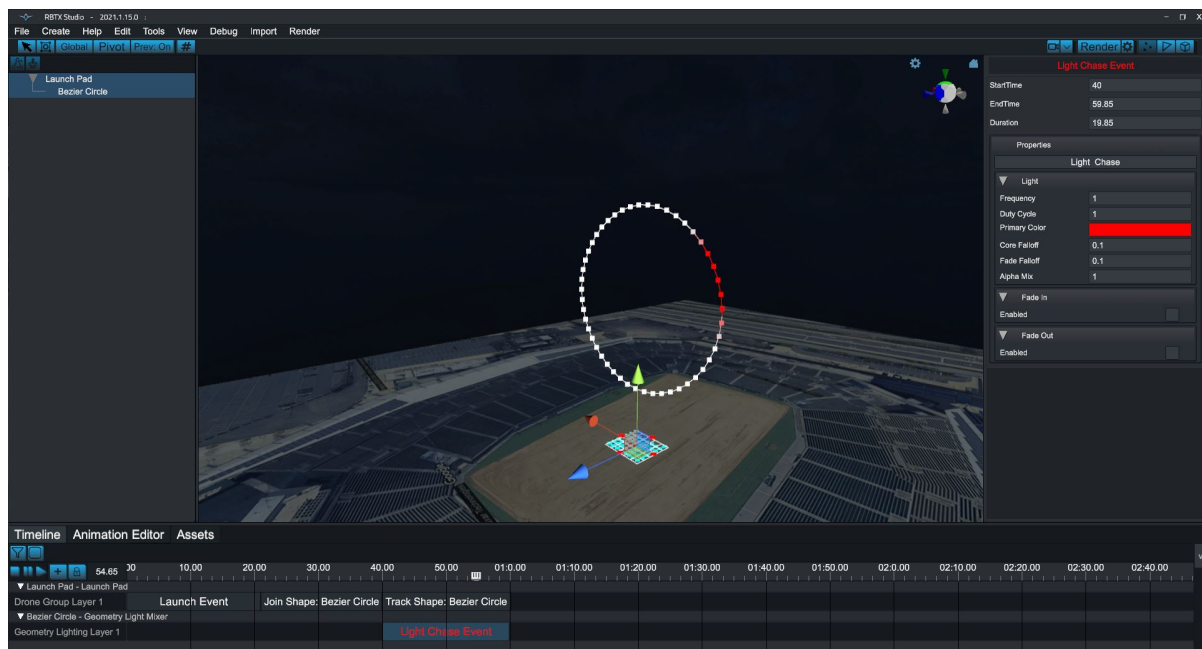


[Join Shape] and [Track Shape] events both with Circle assigned, correctly placed in the Timeline.

## 7. Add a Light Effect to the Circle

- With the Circle object selected in the Hierarchy, navigate to the Inspector and check the option to Use Spline Color.
- At the bottom of the Inspector select *Add Modifier > Light Mixer*. A Lighting Layer will appear in the Bottom Panel.
- To make both the Drone Group Layer and Circle Lighting Layer visible at the same time, navigate to the Hierarchy and holding the CTRL button select both the Launchpad object and the Circle object.
- Lock the layers to keep them both visible by selecting the lock button in the Bottom Panel (circled in the image below).
- Right-click in the Circle Lighting Layer and select *Insert Event > Lighting > Shape Chase*.
- Orient the [Light Chase Event] to align it with the [Track Shape] from the Drone Group Layer.
- With the [Light Chase Event] selected, navigate to the Inspector and click the white color bar. Use the color picker to change the color to red. Click the X in the top right of the color picker to exit the window. Press play to watch the show preview.

The white icon that moves along the timeline is called the playhead. This can be manually dragged along the timeline if you want to watch the preview at a faster pace.



Both Layers visible, Light Chase is colored and oriented correctly, Lock Button is circled.

## 8. Import and Orient a Heart Shape

- Navigate to the Bottom Panel and select the Assets tab.
- Select the Shapes folder and drag the “Heart.svg” file into the Viewing Window.
- With all the default options selected in the dialogue box click *Import*.
- Drag the Heart object into the Launchpad object so it is nested just like the Circle. With the Heart object selected, navigate to the Inspector and right-click *Position* in the transform box to center the Heart on the launchpad.
- Make the following transformations to the Heart in the transform fields of the Inspector

Position Y: 0 to 60

Scale X: 1 to 4

Scale Y: 1 to 4

Scale Z: 1 to 4

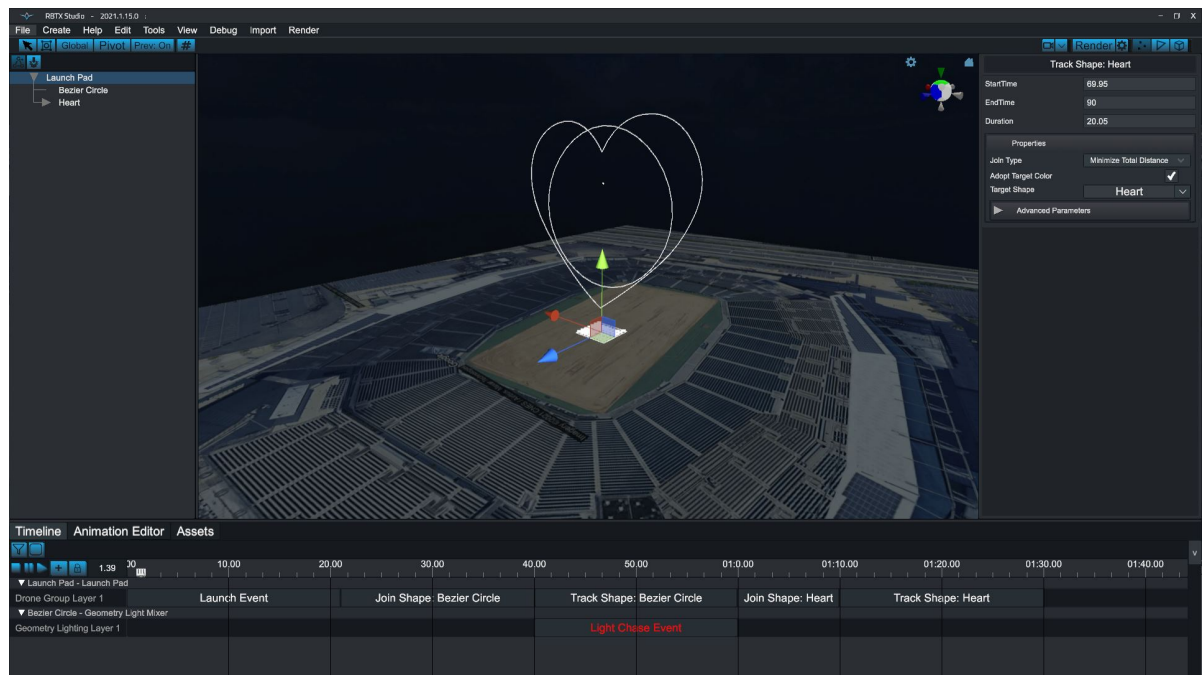
## 9. Join Drones to Heart

- In the Bottom Panel select the Timeline tab to bring the timeline layers back into view. Both the Drone Group Layer and Circle Lighting Layer will be visible.
- Right-click in the Drone Group Layer and select *Insert Event > Join Shape*.

- c. Move the [Join Shape] left to meet the [Track Shape] and drag to extend it to 01:10:00.
- d. With [Join Shape] selected, navigate to the Inspector and click the Target Shape dropdown. Change “Empty” to “Heart” to assign the drones to leave the Circle and join the Heart.

## 10. Track Drones on Heart

- a. Navigate to the Bottom Panel. Right-click in the Drone Group Layer and select *Insert Event > Track Shape*.
- b. Move the [Track Shape] left to meet the [Join Shape] and drag to extend it to 01:30:00.
- c. With [Track Shape] selected, navigate to the Inspector and click the Target Shape dropdown. Change “Empty” to “Heart” to assign the drones to track the Heart for the duration of the event.

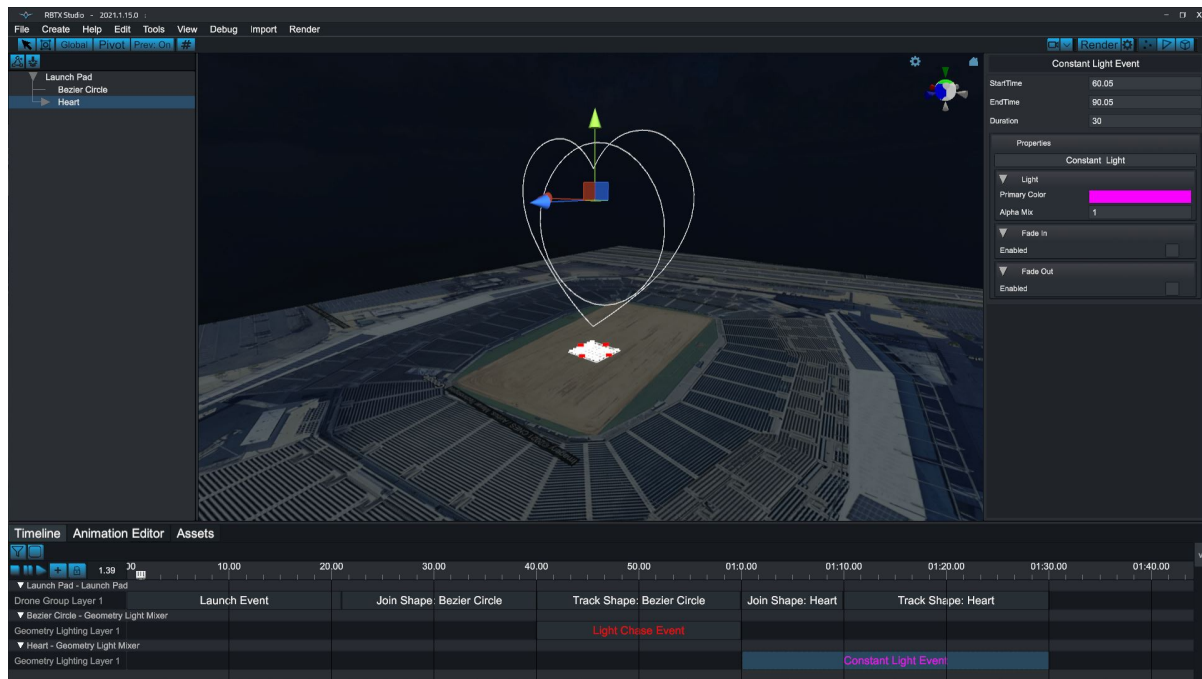


Heart oriented correctly in the scene, Join and Track events for the Heart are in place.

## 11. Add a Light Effect to the Heart

- a. In the Hierarchy select the Heart object. Navigate to the bottom of the Inspector and select *Add Modifier > Light Mixer*. You will not see a new layer appear because only the Launchpad and Circle objects are currently locked into the timeline.

- b. Click the lock button on the timeline to release the selected layers. In the Hierarchy hold CTRL and select the Launchpad object, Circle object, and Heart object and click the lock button again. There will now be three layers visible: the Drone Group Layer, and both Lighting Layers.
- c. In the Heart Lighting Layer right-click and select *Insert Event > Lighting > Constant*.
- d. Orient the [Constant Light Event] so it spans both the Heart's [Join Shape] and [Track Shape].
- e. With [Constant Light Event] selected, navigate to the Inspector and click the white color bar. Use the color picker to change the color to Purple. Click the X in the top right of the color picker to exit the window.



All object layers are visible, [Constant Light Event] has updated color and is placed correctly.

## 12. Add a Rotation to the Heart

- a. In the Timeline next to the play button click the add layer button (circled in the image below) and select *Heart > Transform Layer*.

Note that the entire Bottom Panel can be expanded by dragging up and down on the top of the panel to show more layers.

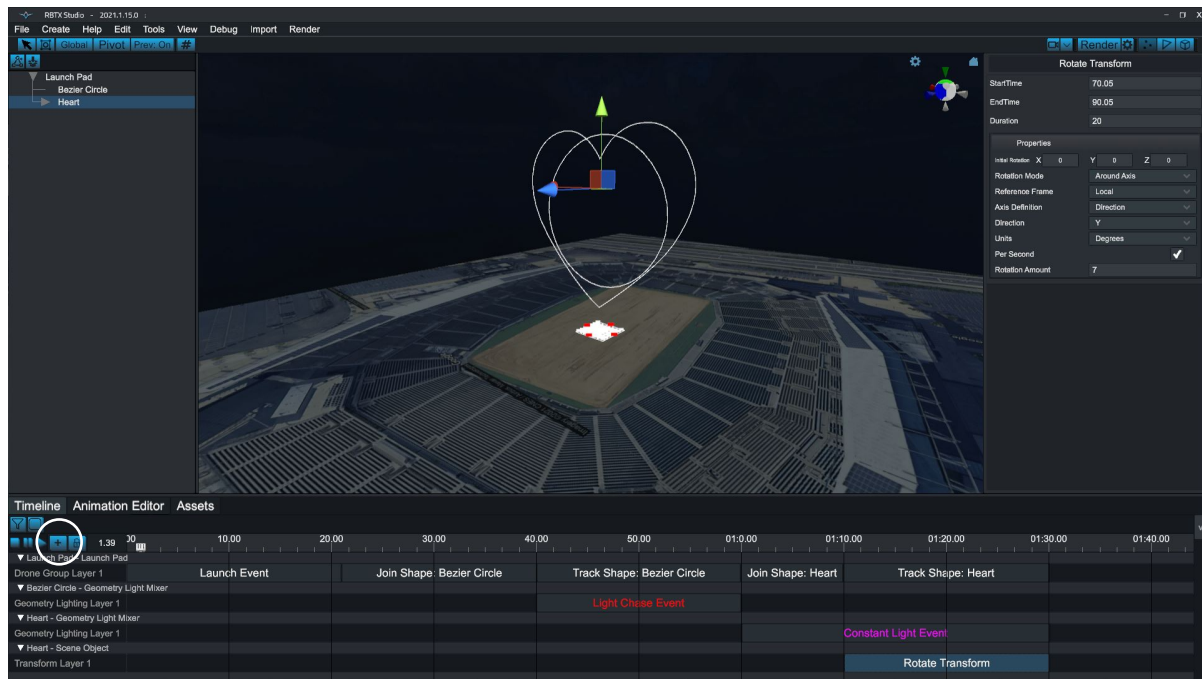
- b. In the Heart Transform Layer right-click and select *Insert Event > Transform > Rotate*.
- c. Arrange the [Rotate Transform] to align with the Heart's [Track Shape].

d. With [Rotate Transform] selected, navigate to the Inspector and update the following fields.

Units: Degrees

Per Second: Checked

Rotation Amount: 7



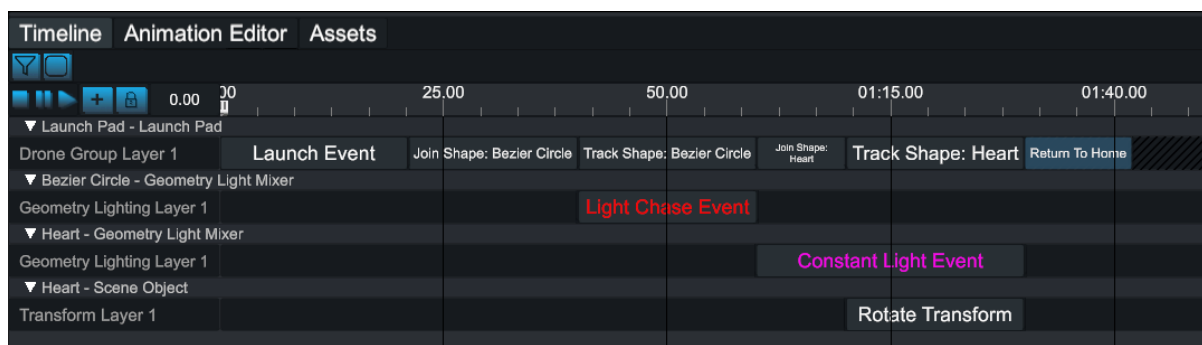
Add Layer button is circled, [Rotate Transform] has updated properties and is placed correctly.

### 13. Add A Return to Home Event

a. Right click on the Drone Group Layer and select *Insert Event > Commands > Return To Home*.

b. Drag [Return To Home] to meet the previous events.

c. Press play or drag the playhead across the timeline to watch the show preview.



Final timeline with all events in correct placement.



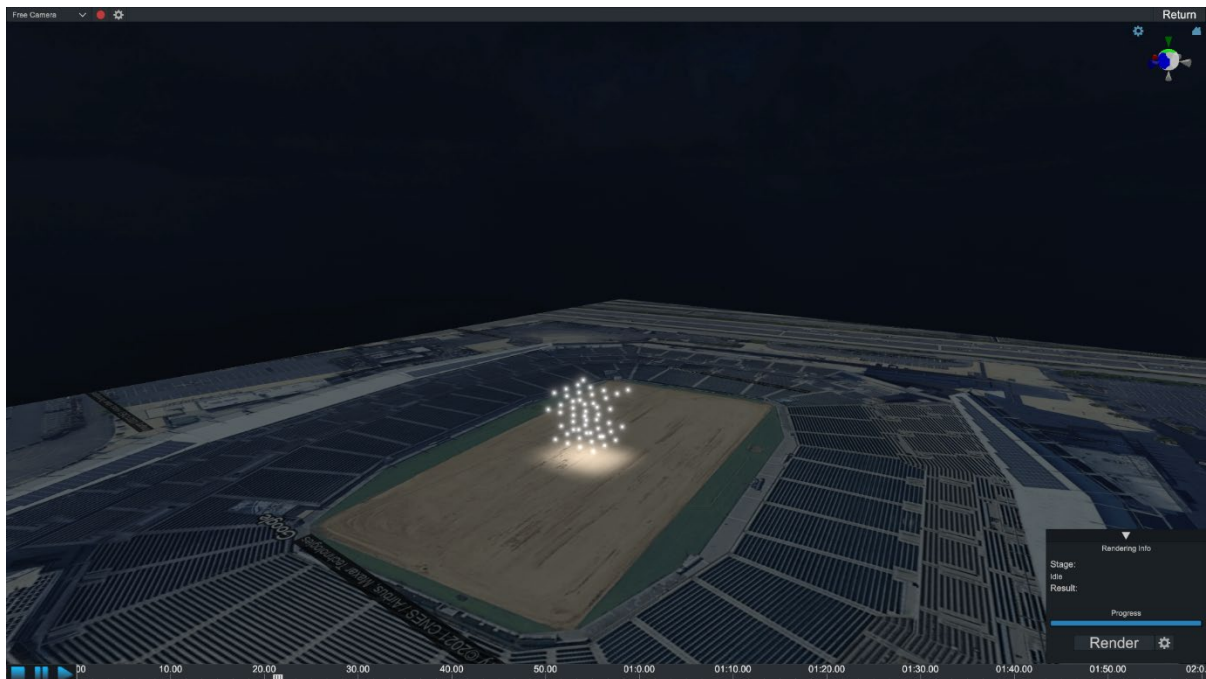
## 14. Render the Show

- On the right-hand side of the Toolbar directly above the Inspector click the blue Render button. You will see a quick preview of the show and then be returned to the editor view.
- Select the camera icon to the left of the Render button to enter Render View.

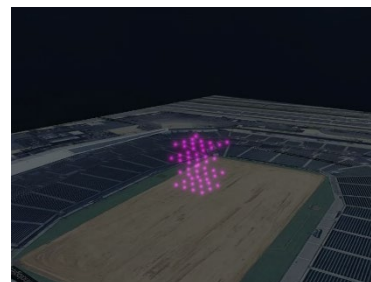
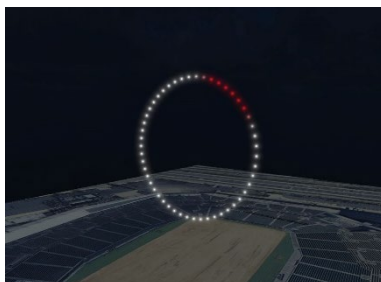


Render View button (far left), and Render button (says "Render")

- Press play or drag the playhead along the timeline to watch the rendered show. Note that the drones do not have lighting until they hit the [Join Shape] event 20 seconds into the show.
- In the top right-hand corner select *Return* to go back to Editor View.



(Above) Full Render View window. (Below) Additional images from the Render.



**Congratulations!** You have just created your first drone show. You now know the essentials of designing a drone show using the Verge Studio. After the launch there are a series of join and track events, and then you end with a return to home event where the drones return safely back to their launchpad positions. To assign the drones to more than one shape at a time, you will use a formation group that consists of multiple objects. Each object/formation can have as many lighting and transform layers as desired, and by stacking these events you can create infinitely complex and incredibly appealing drone shows. This is just the beginning!

# Essential Knowledge

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The following Essential Knowledge section goes in depth on each area of the designer. It provides descriptions for menu items and buttons, as well as objects and events with their associated Inspector properties.

There is a section for each panel of the studio except for the Inspector. Inspector properties are covered with their respective events and objects. Any item that has Inspector properties will be followed by a table like the one below.

Inspector Property	Description of the property will be here.
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To find information on a specific object, event, or property we recommend you use the search function (Ctrl+f) or check the Table of Contents.



# Toolbar

## Standard Toolbar

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File Create Help Edit Tools View Debug Import Render

### File:

<b>New Show</b>	Abandon current show and start a new show file.
<b>Open Recent</b>	Abandon current show and open a recently saved show.
<b>Save Show</b>	Saves progress to a previously defined filename and location. Hotkey: Ctrl+S.
<b>Save Show As...</b>	Defines a filename and location for the project. References assets locally.
<b>Export</b>	Exports the project with all assets nested within the file.
<b>Open Show</b>	Abandon current show and select show from file explorer to open.
<b>Exit</b>	Close the application.

### Create:

<b>Video</b>	Insert a Scene Camera object, Scene Projector object or Director timeline.
<b>Audio</b>	Insert an Audio Source timeline.
<b>Swarm Control</b>	Insert a LaunchPad or empty Formation Group.
<b>Utility</b>	Create a GPS Probe, World Plot, or Empty Object.
<b>Shape</b>	Insert a Preset Shape or text object into the scene.
<b>Effect</b>	Insert a Fireworks or Snowfall event.
<b>Obstacle</b>	Insert a flocking obstacle into the scene.
<b>Controller</b>	Insert a flocking controller.
<b>Light</b>	Insert an independent light source into the scene.

### Help:

<b>Report An Issue</b>	Opens a webpage where issues with the software can be reported.
<b>Open Player Log</b>	Opens the Player Log file.
<b>License</b>	Displays the details of your license.
<b>About</b>	Select to see what version of the software is being run.

### Edit:

<b>Settings</b>	Modify auto-save frequency, Timecode, and DMX options.
<b>Undo</b>	Erases last action taken and reverts to a previous state. Hotkey: Ctrl-Z.
<b>Redo</b>	Reverses an undo command, returning to a more current state.

### Tools:

<b>uLog</b>	Parses an imported uLog file for specific information.
<b>GPS</b>	Select to refresh GPS.
<b>Environment</b>	Select to open the environment properties in the Inspector where GPS coordinates and altitude, as well as maximum flight altitude can be modified. Note that maximum flight altitude allowances vary by country based on regulation.
<b>Lighting</b>	Select to change the lighting in the scene using the Color Picker.
<b>Render Settings</b>	Select to open the background image and render quality options.

### View:

<b>Display</b>	Select Full Screen or Windowed view.
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### Import:

<b>Launchpad</b>	Import a custom launchpad layout.
<b>Model</b>	Import a 3D model into the scene. These can be environment models or 3D shapes for the drones to assign to. The best file format is .fbx.
<b>PointCloud</b>	Import an image to be converted to a Pointcloud Shape.
<b>Shape</b>	Import an image to be converted to a Spline Shape.

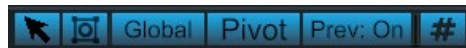
### Render:

<b>Render Show</b>	Select to render a show as well as see the render log.
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## Blue Toolbars

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### Blue Toolbar Left



A      B      C      D

<b>A. Global/Local Toggle</b>	This button changes the reference frame for the transform control handles. Global keeps the transform handles relative to the global axis. Local orients the transform controls relative to the selected object.
<b>B. Pivot/Center Toggle</b>	Toggles between referencing the default anchor point (0,0,0) and weighted center point of object.
<b>C. Preview Toggle</b>	This button turns the show preview on or off. The preview is of the most recent render of the show.
<b>D. Drone Number Toggle</b>	This button reveals or hides the position of each specific drone regardless of its lighting condition.

### Blue Toolbar Right



A      B      C      D

<b>A. Render View</b>	Switch from Editor View to Render View.
<b>B. Render Button</b>	Click to render the show.
<b>C. Render Settings</b>	Click to see modifiable Render Settings
<b>D. Spline Selection Type</b>	When manipulating Spline Shapes, these buttons determine whether you can select vertices, segments, or full splines.

# Viewing Window

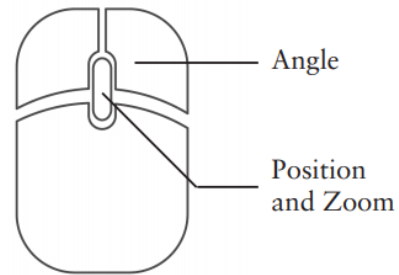
## Controls

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Using the following controls you can orient your view in the scene's 3-dimensional space.

### Viewing Window Navigation

Right-click and hold to change viewing angle.  
Center-click and hold to change viewing position.  
Scroll with the wheel to change viewing zoom.



### Viewing Settings:

<b>Free Cam Mode</b>	Locks the camera location in the scene and allows 360 degree viewing from that position.
<b>Orbit Mode</b>	Camera orbits around whatever object is selected in the hierarchy. If no object is selected it orbits the centerpoint of the ground plane.
<b>Orthographic View</b>	Objects do not change size based on distance from the camera.
<b>Perspective View</b>	Objects that are further from the camera will appear smaller.
<b>Lock Camera</b>	Locks camera location and angle.



**Viewing Gizmo:** Shows the current viewing orientation. The RGB arrows are preset viewing directions correlated to the standard XYZ axes.

**Home:** Focuses the viewing window on whichever hierarchy object is selected in a preset orientation.

## Scene Customization

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The Scene is the environment the show is designed in and is found in the Viewing Window of the studio. It is a 3D space centered on a 2D ground plane. This plane is overlain with google maps satellite photos for accurate placement of the launchpad.

### GPS Coordinates

*Tools > Environment > Edit Environment*

The inspector will display a GPS Config dropdown where users can change the latitude and longitude of their view. To find GPS coordinates of any location, open Google Maps and right-click on the desired location.

### Sunlight

*Tools > Lighting > Sun*

Sunlight color and intensity can be changed by clicking the colorbar next to Light Color. The angle at which the light hits the environment and the shadow mode can also be changed.

### 3D Models

*Import > Model*

To create a 3D environment, models can be imported. Supported file formats are .dae, .obj, .fbx, .blend, .smd, .3ds, .3d, .ply, .raw, and .stl. Best results are found with .fbx files.



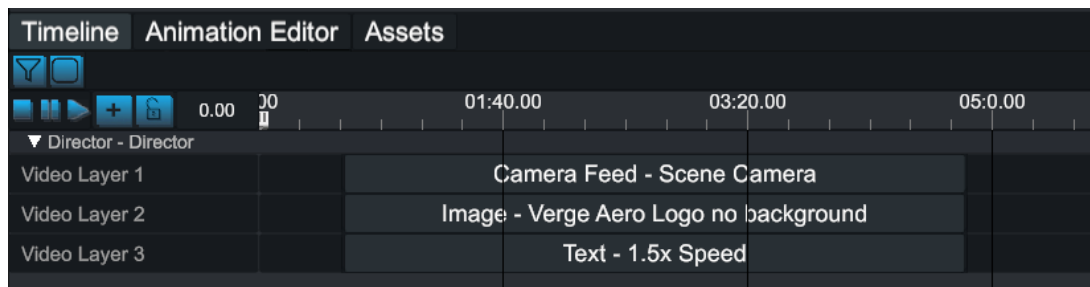
Viewing Window with sample content in a 3D model environment.

## Director View and Scene Cameras

### Director View

*Create > Video > Director*

Director view is a tool that allows the addition of image and text overlays to a render export, as well as the possibility for multiple camera angles. When created, both a Director object and Video Layer are generated. Right clicking in the Video Layer provides three options: Camera Feed, Image Overlay, and Text Box. To add all 3 elements simultaneously 3 video layers must be created. These settings are modified in Editor View the director can only be seen in render window. To change to Director View select the dropdown in the top-left of the render view.



Director timeline with all three layer options being used: a camera feed, an image overlay, and a text overlay.

**Camera Feed:** A camera feed assigns the view of a specific scene camera for the duration of the camera feed event. Note that in director view the render will show a black screen if there is no camera feed assigned.

<b>Camera Reference</b>	Select the Scene Camera to reference during the event.
-------------------------	--

**Text Box:** Adds a text overlay to the Director View.

<b>Text</b>	Input desired text characters.
<b>Color</b>	Use the Color Picker to select text color.
<b>Font Size</b>	Change the size of the text.
<b>Width</b>	Change only the width of the text.
<b>Height</b>	Change only the height of the text.
<b>Text Alignment</b>	Choose Left, Center, or Right justification.
<b>Image Root</b>	Changes the base location of the image.
<b>Offset X</b>	Shifts the image left/right in the X axis.
<b>Offset Y</b>	Shifts the image up/down in the Y axis.

**Image Overlay:** Adds an image overlay to the Director View.

<b>Import Texture</b>	Select desired image from local files.
<b>Scale</b>	Changes the size of the image.
<b>Image Root</b>	Changes the base location of the image.
<b>Offset X</b>	Shifts the image left/right in the X axis.
<b>Offset Y</b>	Shifts the image up/down in the Y axis.

## Scene Camera

*Create > Video > Camera*

Scene Cameras are specific viewing points that can be placed anywhere in the scene to provide a simulated camera angle. They are best used when assigned as Camera Feed events for the Director View, where you can switch from one camera to another or use a transform event to move the camera to create a more cinematic look.



Scene Camera in perspective view, with field of view lines visible.

<b>Mode</b>	Switch between Orthographic and Perspective view.
<b>Size</b>	Changes the size of the viewing field.
<b>Aspect</b>	Changes the aspect ratio of the viewing field.
<b>Near Clip Plane</b>	Distance away from camera where field of view starts.
<b>Far Clip Plane</b>	Distance away from camera where field of view ends.
<b>Aspect Ratio</b>	Select preset aspect ratios.
<b>Toggle Viewer</b>	Select this button to see what the camera sees.

## Render View and Export

Render view displays the rendered version of a show file. The render shows the exact flight paths and lighting as it will look when flown. This differs from the editor view as the preview is not always indicative of true flight paths due to safety radii around each drone as well as speed limits. To enter Render View select the Render View button (See Blue Toolbar Right).



Render View Window Diagram.

<b>A. Camera Selector</b>	A dropdown displaying all possible camera views, including Director view.
<b>B. Export Render</b>	Button that initiates the render export.
<b>C. Export Settings</b>	Displays export settings, see details in the table below.
<b>D. Return to Editor</b>	Button that takes you back to editor view.
<b>E. Render Info</b>	Render information dialogue box. The blue bar displays the render progress. Any errors with the render will appear in this dialogue box in red text.



## Render Export Settings

<b>File Name</b>	Select a name and file location for the exported render. If unspecified the render will be saved in the VergeShowDesigner Media folder.
<b>Drone Light Brightness</b>	Select the brightness of the drone lights.
<b>Drone LOD Distance</b>	Distance from camera at which drone model disappears.
<b>Use Show Length</b>	Will render the show from initiation of the launch event to the conclusion of the return to home event.
<b>Start Time</b>	Manually input start time of render (seconds).
<b>End Time</b>	Manually input end time of render (seconds).
<b>Width</b>	Width of the rendered video in pixels.
<b>Height</b>	Height of the rendered video in pixels.
<b>Frame Rate</b>	Frame rate of rendered video.
<b>Playback Speed</b>	Change the speed of the render. A playback speed of 2 will display the lightshow at 2x speed.

# Hierarchy

## Launchpad

---

### Launchpad

*Create > Swarm Control > Launch Pad*

Sizing and orienting your launchpad is a critical aspect of designing a successful show. The number of drones in the launchpad determines exactly how many drones will be required to fly your show as designed in the studio. Additionally, the specific GPS location of the launchpad in the studio is where the drones will need to be placed in the real world to take off. To ensure you make an appropriate launchpad, design on the GPS coordinates of your intended show location.

### Launchpad Formation Options

<b>Grid</b>	A rectangle formation that arranges drones in equally spaced rows and columns to fill the shape.
<b>Circle</b>	A circle formation that arranges drones on the outline of the shape.
<b>Rectangle</b>	A rectangle formation that arranges drones on the outline of the shape.
<b>Poly Grid</b>	Allows for manual manipulation of vertex points to create a launchpad of any polygonal geometry. To add additional vertex points, right-click anywhere on the grid and select Insert Point. Modify the shape by using the position handles that appear when a point is selected.
<b>Arbitrary</b>	This formation encompasses all imported launchpads. A .csv file with specific Cartesian coordinates can be imported to designate individual drone locations for fully custom launchpads.

### Inspector Properties

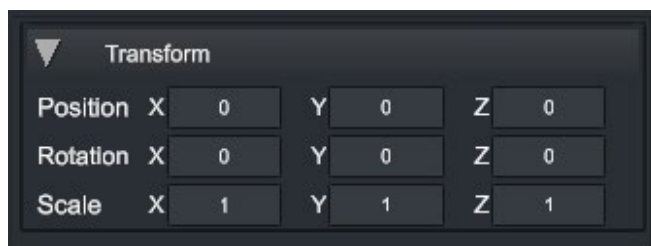
<b>Drone Count</b>	Number of drones in the launchpad.
<b>Width</b>	Width of the launchpad in meters.
<b>Length</b>	Length of the launchpad in meters.
<b>Drone Spacing</b>	Displays the distance between drones in meters. The minimum allowable distance is 1.5 m. If your grid density is below this value an error will occur. Manipulate this value by changing the size of the launchpad or the number of drones in the launchpad.
<b>Constant Density Mode</b>	When selected, the user determines a set spacing between drones in the launchpad.
<b>Drone Preview Size</b>	Size of drone preview square in editor view.

# Transformations

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## Transform Fields

Transform parameters are found at the top of the Inspector anytime an object is selected. Upon import, objects automatically reference the center of the ground plane. If an object is nested it references the position of the parent object. The values displayed in the transform fields represent the difference between the selected object and its reference point - either the groundplane center or a parent object. The Right-clicking on any of the field titles (Position, Rotation, Scale) will reset all axes to 0.



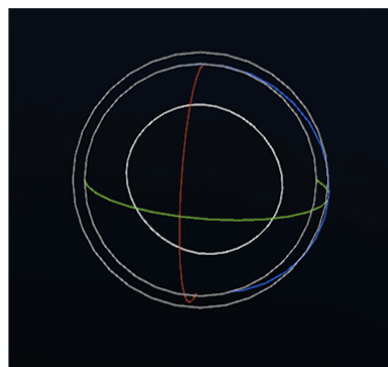
Transform fields with base values.

Each transform class can be modified in three ways:

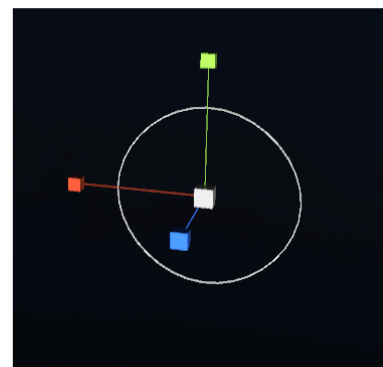
- 1.) Typing specific numbers into the Inspector fields.
- 2.) Click and drag over any field to change the values with a slider.
- 3.) Use the handles to change the object in the Viewing Window. The transform hotkeys are W for position, E for rotation, and R for Scale.



Position Handles (W)



Rotation Handles (E)



Scale Handles (R)

## Preset Shapes and Text Tool

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### Preset Shapes

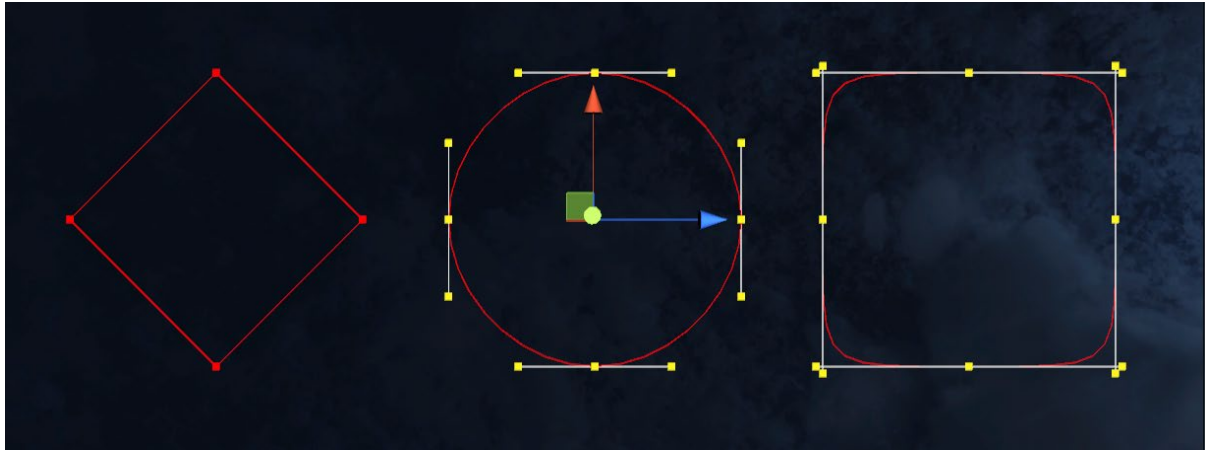
*Create > Shape*

<b>3D - Sphere</b>	Sphere geometry with default radius of 5 meters.
<b>3D - Helix</b>	Helix geometry with defaults of one full turn, radius of 1 meter and height of 1 meter.
<b>2D - Circle</b>	Circle geometry where drones are only assigned to the shape outline. Default radius of 1 meter.
<b>2D - Fill Circle</b>	Circle geometry where drones are distributed evenly over the entire area of the shape. Default radius of 5 meters.
<b>2D - Grid</b>	Rectangle geometry where drones are distributed evenly over the entire area of the shape. Default height and width of 5 meters.
<b>2D - Line</b>	Straight line segment with default length of 1 meter.

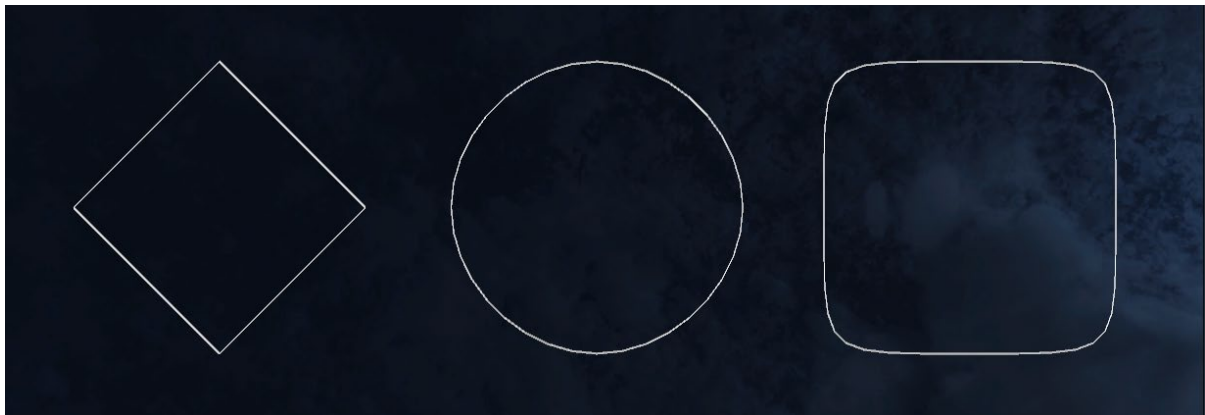
### Common Shape Inspector Properties

<b>Radius</b>	Radius of the sphere or circle in meters.
<b>Width, Length, Height</b>	Size of the respective dimension in meters.
<b>Use Pivot Weighting</b>	When selected, vertex points are given priority for drone placement.
<b>Pivot Angle Threshold</b>	Angles below this value (in degrees) are considered vertex points and are given priority for drone placement.
<b>Is Looping</b>	Select to close open ended shapes by connecting the ends together.
<b>Use Spline Color</b>	Check this box to assign the spline color to the drones without a light event.
<b>Smooth Mode</b>	Preset circularity options.
<b>Placement Mode (Sphere)</b>	Determines the method of drone distribution on the sphere.
<b>Num. Turns (Helix):</b>	Sets the number of full turns for the helix geometry.

**Circularity:** Spline circles are formed with 4 anchor points and median control handle lengths. The circularity value determines the length of control handles as shown below. Short control handles create a sharp box shape while long control handles create a smoothed box shape.



Spline Circles in different Smooth Modes with Control Handles shown.



(From Left to Right) Smooth Modes: Hard, Circular, Smooth.

## Spline Options

Many of the included shapes (helix, circle, line, and segment) are simply pre-defined splines. They are fully editable by selecting the “To Editable Spline” button located in the bottom of the inspector properties. Splines are created by passing through a succession of anchor points, each having two control handles to further control the curvature of the spline coming in and out of the anchor point. Note that end anchor points only have one control handle. Both anchor and control points are manipulated by selecting them in the viewing window and dragging the position handles until the point is at the desired location. To create a new anchor point, right-click anywhere on the spline and select *Insert*.

## Control Point Mode

Right-clicking on an anchor point allows users to change the Control Point Mode.

<b>Free</b>	Control points can be manipulated separately with no relation to each other.
<b>Aligned</b>	Forces control points to stay aligned through the anchor point, though the length of the control points can be different.
<b>Mirrored</b>	Forces control points to stay aligned through the anchor point and the length of the control points are always equal.
<b>Corner</b>	Eliminates control points to achieve a sharp corner.

## Spline Shape Inspector Properties

<b>Interpolation</b>	The number of straight lines that comprise the curve between any two anchor points. A higher interpolation will create a smoother curve.
<b>Reverse Curve</b>	Reverse the direction of the spline.
<b>Add Curve</b>	Add an additional anchor point to the end of the spline.
<b>Export</b>	Save the spline as a .csv file with relative coordinates for each anchor and control point.
<b>Center Anchor</b>	Toggles the spline pivot point between the weighted center of the object and the default anchor point (0,0,0).
<b>Smooth Spline</b>	Sets the control point mode for all anchor points to mirrored to create a smooth spline.

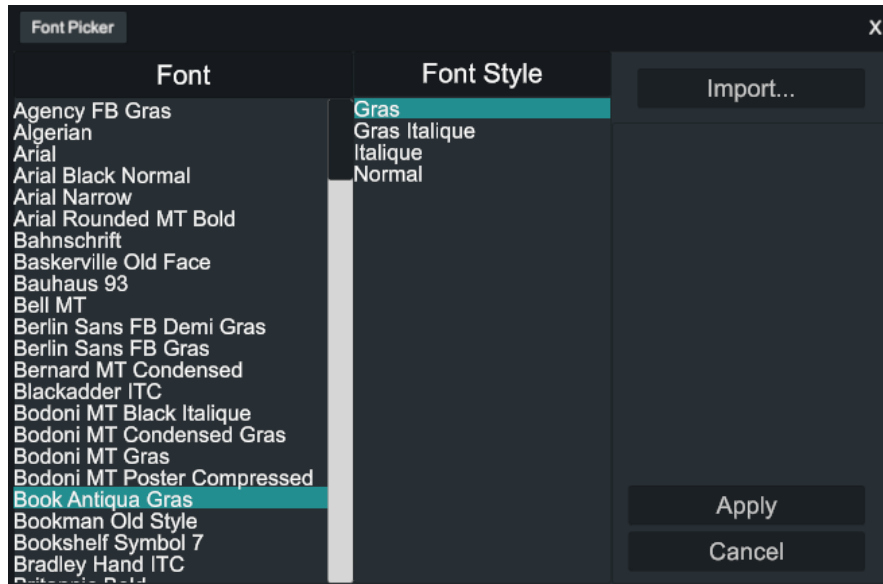
## Text Tool

*Create > Geometry > Text*

The text tool allows for creation of block characters in one of many different font options. Drones are assigned only to the outline of each character.

<b>Content</b>	Input field for desired characters.
<b>Font Size</b>	Size of the font. Note that size can also be modified by changing the object's scale field.
<b>Extra Spacing</b>	Add spacing between characters in any of the three dimensions.
<b>Anchor Offset</b>	Offset the characters from the default anchor location at the bottom left corner of the geometry.
<b>Color</b>	Click on the white bar to change the text color in the color picker.

**Font:** Displays the font that is in use. Click on the current font name to bring up the Font Picker window. In the Font Picker select any font to see a preview of the text in the Viewing Window. If the font has multiple font styles those options will appear in the Font Style column. Custom fonts can be imported in the .ttf file format using the Import button.



Font Picker Window

## Custom Shapes

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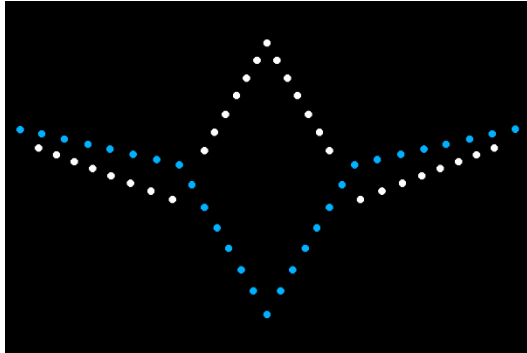
There are two main types of custom shape that can be imported into the studio. Point cloud shapes which consist of specified locations for each drone, and spline shapes which consist of paths for drones to be distributed on.

### Point Cloud Shapes

Point cloud shapes can be created in any graphics editor (MS Paint, Photoshop, etc) by placing individual points of color on a black background. Each point corresponds to the location of a single drone. This is a useful method if a design requires a specific number or placement of drones. The studio will assign each drone a color, thus the color of each point will become the default color of the corresponding drone in the shape. For this reason the background of the image must be black or transparent for the software to identify the shape correctly. Otherwise the studio will attempt to assign a drone location to every pixel in the background and the shape will not import.

The best file format for import is .png.

To import a point cloud save the image in VergeShowDesigner > Shapes and drag it into the viewing window from the assets tab and select Import As > Point Cloud.



Good Point Cloud Image



Bad Point Cloud Image

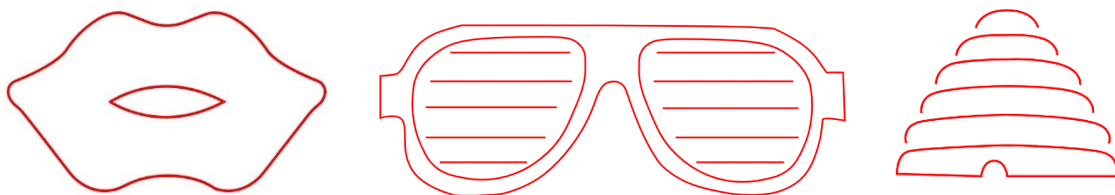
Designs of black backgrounds with colored points allow the studio to identify each point as a specific drone location with a specific color. White backgrounds act as an infinite number of white drone locations and the studio will reject the image.

## Spline Shapes

Spline shapes can be created in any vector graphics editor (Inkscape, Illustrator, etc) and are composed of one or more individual spline paths. Spline shapes are more adaptable than point cloud shapes because they are not defined by a fixed number of points. Changing the size of the shape allows for accommodation of more or less drones depending on the needs of the show. Splines import automatically as a formation group consisting of one or more formation elements. Each element is assigned a percentage based on line length (this is known as flexible allocation) and corresponds to the fraction of the swarm that will be assigned to that element's geometry. This ensures even drone density across the full shape.

The best file format for import is .svg. Note that when exporting .svg files from Illustrator, the CSS Properties must be Style Attributes to retain the spline color upon import.

To import a spline save the file in VergeShowDesigner > Shapes and drag it into the viewing window from the assets tab and select Import. Below are examples of good spline shapes.





# Formation Groups

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## Formation Groups

*Create > Swarm Control > Formation Group*

Formation groups are one of the most critical aspects of the studio. A formation group acts as a single object and consists of one or more formation elements. A swarm can only be assigned to one object at a time, therefore, to assign the drones to multiple independent shapes simultaneously a formation group must be used. A formation group can have any number of elements, with each element referencing a single hierarchy object (individual shapes or other formation groups).

A formation group generated using the create menu will automatically be empty and require the user to then populate the formation group with the desired objects. Alternatively, with multiple objects selected in the Hierarchy, clicking the Formation Group button will generate a formation group consisting of all selected objects with drones allocated equally between each element.



Formation Group Button (Left). Found directly above the Hierarchy.

## Allocation Mode: Fixed vs. Flexible

Both formation groups and the formation elements within them are defined by an allocation mode. All the formation elements in a group are related, though they can have different allocation modes. Fixed formation elements take precedence as they require a specific number of drones, followed by flexible formation elements which split the remainder of the swarm based on their flexible slot weights.

Flexible slot weighting is the method used to divide the remaining swarm between multiple flexible formation elements. The remaining swarm is split based on the ratio of the flexible slot weights. See examples below.

When a flexible formation element is created, the default slot weight is 1. When a spline shape is imported and a formation group is generated automatically, the sum of all the slot weights will add to 1. Flexible formation elements can also designate minimum and/or maximum drone numbers to assign to their associated object.

## Flexible Slot Weighting Examples

If elements A, B, and C have slot weights of 1, 1, 1 the remaining swarm will be split evenly between them (because they all have the same weight).

If elements A, B, and C have slot weights of 0.5, 1, 1 element A will get half as many drones as elements B and C.

If elements A, B, and C have slot weights of 0.1, 0.6, 0.3 then element A will get 10% of the remaining drones, element B will get 60% of the remaining drones, and element C will get 30% of the remaining drones. These can be converted to percentages since they add to 1.

The specific numbers of the slot weights don't matter, what matters is their weight relative to the sum of all the slot weights in the group.

On the group level (as opposed to the element level) allocation mode only matters if the formation group is being nested into another formation group. In which case the nested group acts like a formation element within the parent group. The allocation mode of the parent group does not matter because it will always be assigned the full swarm.

## Formation Group Inspector Properties

<b>Light Blending</b>	Determines whether lighting events associated with the full group or with the elements take precedence.
<b>Formation Elements</b>	Select the plus sign to add more elements to the formation.
<b>Shape Reference</b>	Hierarchy object assigned to that specific formation element.
<b>Exclude From Lighting</b>	Select to exclude the element from lighting events associated with the full formation group.
<b>Light Group Mode</b>	When grouped, all elements in the formation group act as one object (a Light Chase Event would move through the elements sequentially). When individual, each element in the formation group act as separate objects (a Light Chase Event would move through all elements at the same time).
<b>Draw Formation Preview</b>	: Select to show a preview of drone placement on the formation. This preview only works if the group is flexible and at least one of the elements is flexible.
<b>Preview Slot Count</b>	Number of drones in the formation preview.
<b>Formation Preview Size</b>	Size of the drone placeholder square for the formation preview.

## Prefab Sequences (Vfabs)

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A Prefab Sequence is a user-created preset that contains a Hierarchy object with all of its associated properties and timeline events. These sequences have the file extension .Vfab and are commonly referred to as such. Note that to prefab a formation group all of the formation elements must be nested within the group in the hierarchy.

To create a Vfab select the desired object(s) in the Hierarchy and click the PreFab button. It is recommended to save Vfabs into the VergeShowDesigner > FX folder. To import a Vfab navigate to the Assets Tab, open the FX folder, and drag the desired Vfab into the Viewing Window.



VFab Button (Right). Found directly above the Hierarchy.

## Nesting and Empty Objects

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### Nesting

Hierarchy objects can be nested, un-nested, and rearranged freely. To rearrange an object's position simply click and drag it to the desired position. To nest an object click and drag it on top of the desired parent object. To un-nest an object click and drag it outside of the parent object. Nested objects are oriented relative to their parent objects. If you transform the parent object all the children objects will be transformed accordingly.

### Empty Objects

*Create > Utility > Empty Object*

A helpful tool for content organization is the Empty Object. These objects act as folders, and allow objects to be nested within them in the hierarchy. Additionally, empty objects exist in the scene and are defined at a specific point in space although they have no geometry. They can be used as a parent object to orient content in a specific location. Empty Objects cannot be assigned to join or track events.

# Bottom Panel

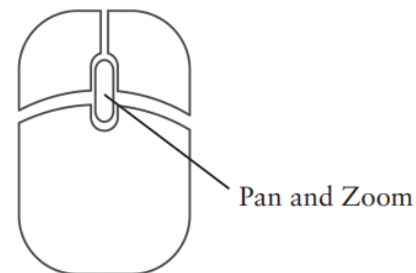
## Timeline Tab

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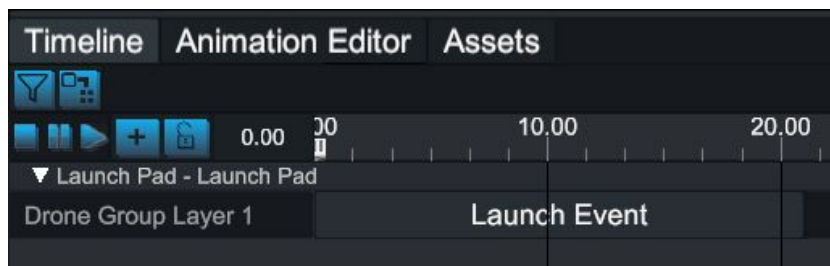
The studio uses multiple layers correlated to a global timeline to separately control swarm movement, transformations, and lighting. Each item on a timeline is called an event. Selecting an event will open the respective properties in the Inspector. Global time information is displayed at the top of the inspector (Time Start, Time End, Duration) followed by event-specific properties.

There are four timeline categories: Swarm Timelines, Lighting Timelines, Transform Timelines, and Audio Timelines. Each type of timeline has different event options. Events are created by right-clicking on a timeline and selecting the desired event type. Each timeline category and their respective events are reviewed in the following sections of the guide.

**Timeline Navigation**  
Center-click and hold to pan the timeline.  
Scroll with the wheel to zoom in and out.



## Timeline Anatomy



Standard Timeline View in the Bottom Panel.

<b>Filter Button</b>	Select which Layer categories are visible/invisible.
<b>Show/Hide Children</b>	Displays or hides all children timelines of selected object.
<b>Stop/Pause/Play</b>	Stop returns playhead to beginning, pause and play are standard.
<b>Add Layer Button</b>	Add a layer to any object that is open in the timeline.
<b>Lock</b>	Locks selected layers to be visible until unlocked.
<b>Playhead</b>	White cursor that indicates the current location along the time ruler.

## Additional Timeline Actions

**Add/Remove Time from Events:** Right-clicking on the playhead allows the user to add/remove time from all events occurring at the playhead. To add seconds to the events input a positive number. To remove seconds from the events input a negative number.

**Select/Deselect Multiple Events:** Click and drag along the time ruler to select all visible events in the range of selected time. Ctrl+Click to add or remove individual events from selection.

**Duplicate an Event:** Hold shift and drag the desired event(s) to an open area of the same layer.

## Drone Group Layers (Swarm Layers)

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Drone Group Layers, commonly known as Swarm Layers, are generated automatically when a Launchpad object is created. This layer hosts the events that control the full swarm for any specific launchpad. Below are the different events that can be added to a Swarm Layer.

### Launch Event

Automatically generated on Swarm Layers this event provides a takeoff sequence to get the drones safely from their launchpad positions into the air. Depending on the number of drones in the swarm and the size of the launchpad, the swarm may take off all together or staggered in groups.

<b>Launch Height</b>	The takeoff sequence launches drones straight up to a designated height before they are allowed to join their first shape. This option determines that height in meters.
<b>Launch Group Stagger Distance</b>	If the launchpad is a size that requires multiple launch groups this option determines the distance between each shelf in meters. There is a bottom limit of 2 meters.
<b>Enable Shape Transition</b>	Selecting this property allows each drone group to begin joining the first formation the moment they reach launch height. If unselected a join event will be used to transition the swarm to their first formation all together.
<b>Transition Time</b>	Designate how long it will take (in seconds) for the drones to transition from the launch height to the designated formation. Note that you will be limited by the drones speed limit of 6 m/s.

## Join Shape Event

Transitions the swarm to a designated formation

<b>Traverse Speed</b>	Displays the speed of the drones wherever the playhead is located in m/s. The speed limit of the drones is 6 m/s.
<b>Adopt Target Color</b>	Select this option to apply the color of the referenced object for the duration of the event.
<b>Target Shape</b>	Selection box determining which hierarchy object is being referenced.
<b>Enable Stagger</b>	Select this option to have the swarm join a formation sequentially rather than all at once. This setting will hold up to 50% of drones on the previous formation to create a delayed transition.

## Track Shape Event

Holds the drones on a designated formation.

<b>Adopt Target Color</b>	Applies the color of the referenced object for the entire event.
<b>Target Shape</b>	Selection box determining which hierarchy object is being referenced.

## Return to Home Event

Provides the landing sequence to transition the swarm from the last formation safely back to the launchpad.

<b>Traverse Speed</b>	Drone speed from last formation to landing formation.
<b>Stage Stagger Distance</b>	Distance between shelves during landing event.
<b>Stage Starting Alt</b>	Altitude where shelves form to initiate landing event.
<b>Land Mode</b>	Staged (in multiple shelves) or Simultaneous (all at once, requires more space).

## Lighting Layers

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Lighting events can be applied to the full swarm, formation groups, or individual objects. To apply a lighting event a designated lighting timeline must be created. Any lighting event added to a timeline will be applied to the associated object. To create a lighting timeline select the desired object in the Hierarchy and then navigate to the Inspector and select *Add Modifier > Light Mixer* at the bottom.

## Multiple Lighting Layers

Any hierarchy object can have multiple transform layers. By layering different transform events on top of each other complex movements can be achieved.

## Constant Light Event

Applies the primary color for the duration of the event.

<b>Primary Color</b>	Color being used for the event.
<b>Alpha Mix</b>	Image transparency. This value ranges from 0-1 with 0 being invisible and 1 being fully visible.

## Strobe Light Event

Blinks between the primary color and no color.

<b>Primary Color</b>	Color being used for the event.
<b>Frequency</b>	How many cycles of the event per second.
<b>Duty Cycle</b>	Percentage of time the light is on in a full cycle. A value of 0.5 means the light is on 50% of the time, a value of .1 means the light is on 10% of the time.
<b>Alpha Mix</b>	Image transparency. This value ranges from 0-1 with 0 being invisible and 1 being fully visible.

## Shape Fill Light Event

Illuminates a formation one time via different effects.

<b>Primary Color</b>	Color being used for the event.
<b>Fill Effect</b>	Determines the method in which the shape will be filled. See table below for each option.
<b>Fade Length</b>	How long it will take the light to fade in to full illumination.
<b>Alpha Mix</b>	Image transparency. This value ranges from 0-1 with 0 being invisible and 1 being fully visible.

## Fill Effect Options

<b>Out to In</b>	From the outside to the center.
<b>In to Out</b>	From the center to the outside.
<b>Left Fill</b>	From left to right.
<b>Right Fill</b>	From right to left.

### Pulse Light Event

Fades between the primary color and no color.

<b>Primary Color</b>	Color being used for the event.
<b>Frequency</b>	How many cycles of the event per second.
<b>Phase</b>	Change the point in the phase cycle at which the event begins.
<b>Alpha Mix</b>	Image transparency. This value ranges from 0-1 with 0 being invisible and 1 being fully visible.

### Shape Chase Light Event

For spline shapes a color core is cycled around the formation one spline at a time, for point cloud shapes a color core cycles vertically through the formation.

<b>Frequency</b>	How many cycles of the event per second.
<b>Duty Cycle</b>	Percentage of time the light is during a full cycle. A value of 0.5 means the light is on 50% of the time, a value of .1 means the light is on 10% of the time.
<b>Primary Color</b>	Color being used for the event.
<b>Core Falloff</b>	Size of the core. A larger value creates a larger core. A value of 1 covers the entire formation.
<b>Fade Falloff</b>	Fade on both sides of the core. A larger value creates a longer fade.
<b>Alpha Mix</b>	Image transparency. This value ranges from 0-1 with 0 being invisible and 1 being fully visible.

### Sparkle Light Event

A random light-noise generator. Creates an irregular pattern of flickering lights.

<b>Random Seed</b>	Choose a different number to get a different projection pattern.
<b>Primary Color</b>	Color being used for the event.
<b>Sparkle Generator</b>	Perlin (Random) or Deterministic (Repetitive Pattern).

### Deterministic Inspector Properties

<b>Duty Cycle</b>	Percentage of time each individual pixel is on in a full cycle. A value of 0.5 means 50% of the drones will be illuminated at any time, a value of .1 means 10% of the drones will be illuminated at any time.
<b>Frequency</b>	How quickly the pattern cycles through the formation.



## Perlin Inspector Properties

<b>Alpha Mix</b>	Image transparency. This value ranges from 0-1 with 0 being invisible and 1 being fully visible.
<b>Noise Scale</b>	Changes the scale of the noise projection image.
<b>Step Threshold</b>	Determines how many levels of brightness there are between full brightness and off. The higher the step value the less steps there are.
<b>Peak Threshold</b>	Determines percentage of drones at full brightness at any given point. The higher the peak value the less full brightness drones there are.
<b>Perlin Offset</b>	Determines the offset of the pattern in the X and Y direction.
<b>Scroll Vector</b>	Determines the scrolling movement of the sparkle projection. Default is X=1 meaning the projection moves in the positive X direction.
<b>Time Scale</b>	How fast the projection is moving through the formation.
<b>Mapping</b>	Change the plane the pattern is being projected onto.

## Fade In / Fade Out

Each light event has the option to Fade In and Fade Out.

<b>Fade Method</b>	Choose the Fade Method from a list of easing functions.
<b>Fade Units</b>	Units for the length of the fade. See table below for options
<b>Fade Length</b>	Input desired length of the fade relative to the selected unit.

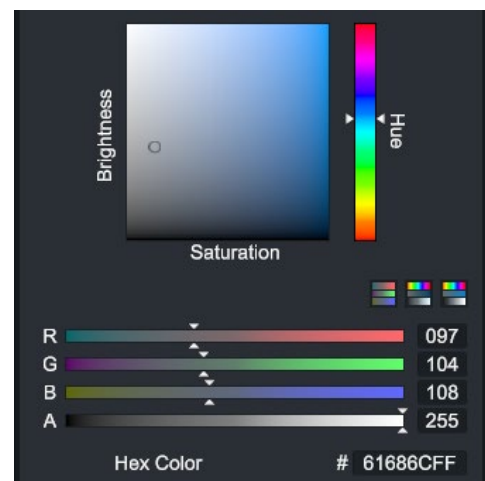
## Fade Unit Options

<b>Normalized</b>	Relative to the length of the event on the timeline. Between 0-1.
<b>Percentage</b>	Percentage of the event. Between 0-1.
<b>Time Length</b>	Fade for a specific amount of time (seconds).

## Color Selection

Verge drones are illuminated by RGBW LED lights. Using the Color Picker, any color on the RGBW range can be achieved on the drones. This can be done manually by dragging the hue slider and selecting a specific shade on the chart, using the RGBA sliders below the chart, or inputting a specific Hex Color code into the field at the bottom.

Note that the color black (at the bottom of the chart, no brightness) turns the drone's light off. For maximum brightness select colors at the top of the chart.



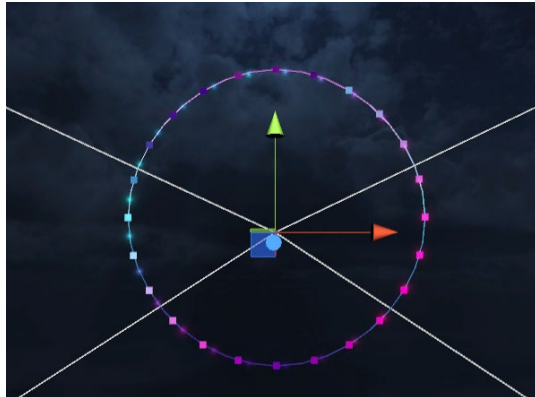
Color Picker Window.

## Projection Light Event

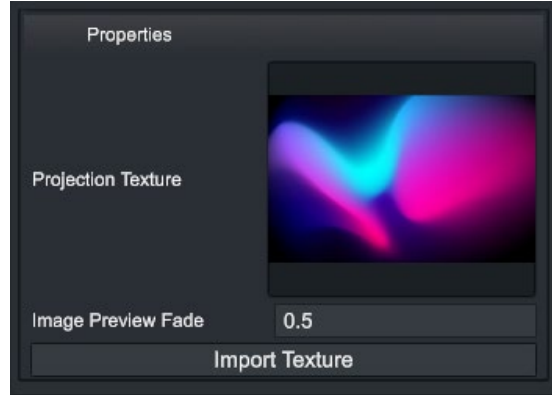
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A projection light event projects an imported image onto a formation. Below are the steps to create a projection light event.

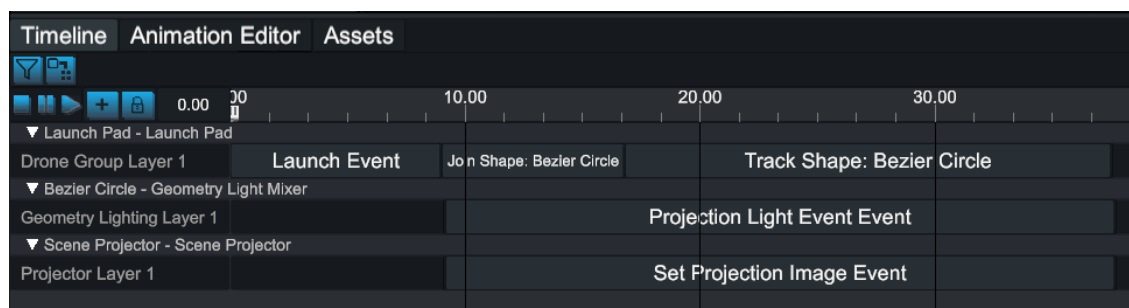
1. Right-click on a lighting layer and select *Insert Event > Projection*. This creates a [Projection Light Event].
2. In the Toolbar select *Create > Video > Projector* to create a Projector object and Projector Layer.
3. On the Projector Layer right-click to Insert Projector Image. This creates a [Projection Image].
4. Select the [Projection Image]. In the Inspector select Import Texture to choose the desired image from your local files.
5. Select the [Projection Light Event]. In the Inspector change the Target Projector from "Empty" to the desired Projector Object.
6. Orient the projected image by selecting the Projector object in the Hierarchy and moving it within the scene. To see the field of view the image is covering in the scene select Toggle Viewer in the Inspector.



Projector Object with field of view lines visible.



Scene Projector Inspector Properties.



Projection Light Event required Layers and Events.

## [Projection Light Event] Inspector Properties

<b>Target Projector</b>	Select the Projector object for the event to reference.
<b>Enable Boundary Culling</b>	Cut off the image from propagating in specific directions.
<b>Alpha Mix</b>	Image transparency. This value ranges from 0-1 with 0 being invisible and 1 being fully visible.

## Projector Object Inspector Properties

<b>Mode</b>	Perspective vs Orthographic view.
<b>Fov</b>	Change the size of field of view.
<b>Aspect</b>	Change the aspect ratio of the projection.
<b>Near Clip Plane</b>	Distance from projector where projected image will begin.
<b>Far Clip Plane</b>	Distance from projector where projected image will end.
<b>Opacity</b>	Change the opacity of the projection.
<b>Boundary Effect</b>	Determine what happens to drones that are outside the boundary of the projected image. See the table below.
<b>Aspect Ratio</b>	Select preset aspect ratios.
<b>Toggle Viewer</b>	Select this button to see what the projector sees.

## Boundary Effect Options

<b>Wrap</b>	Repeats the image in a tiled manner.
<b>Ping Pong</b>	Repeats the image in a tiled manner, flipping the image on the repeating axis every time.
<b>Clamp</b>	Extends colors at the edge of the image indefinitely.
<b>Clear</b>	Turns the lights off for any drones outside the image.

## Transform Layers

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Transform events can be applied to the full swarm, formation groups, or individual objects. To apply a transform event to any group of drones a separate timeline must be created. With an object selected in the Hierarchy a transform timeline is created by clicking the Add Layer button and selecting *Transform Layer*.

## Multiple Transform Layers

Any hierarchy object can have multiple transform layers. By layering different transform events on top of each other complex movements can be achieved.

## Linear Move Transform

Transfers a formation from one location to another in a linear fashion over the length of the event.

<b>Start Position</b>	Current position coordinates of formation.
<b>End Position</b>	Desired final position coordinates of formation.
<b>Face Forward</b>	Orients formation to face the direction of movement.
<b>Easing Function</b>	Easing functions can be found <a href="#">here</a> .

## Scale Transform

Changes the size of a formation over the length of the event.

<b>Initial Scale</b>	Initial size of the formation.
<b>End Scale</b>	Final size of the formation.
<b>Ease</b>	Easing functions can be found <a href="#">here</a> .

## Move on Spline Revolutions

Transfers a formation along a closed loop spline path for a designated number of iterations.

<b>Clamp At End</b>	End movement after 1 full revolution.
<b>Face Forward</b>	Orients formation to always face the direction of movement.
<b>Target Spline</b>	Designate the spline which the formation will move along.

## Rotate Transform

Spins a formation around a specified axis.

<b>Rotation Mode</b>	Select Around Axis to rotate around the predefined X, Y, or Z axis, or Custom to input the amount of rotation in each axis individually.
<b>Reference Frame</b>	Select Local to rotate around the formation's local axis or Global to rotate around the scene global axis.
<b>Rotational Axis</b>	Select which axis to rotate around: X, Y, or Z.
<b>Units</b>	Select the unit of rotation in Rotations or Degrees.
<b>Per Second</b>	If unchecked the rotation will occur over the length of the event. If checked the rotation will occur at a constant rate per second.
<b>Rotation Amount</b>	Input a numerical value to define the amount of rotation.

## Audio Layers

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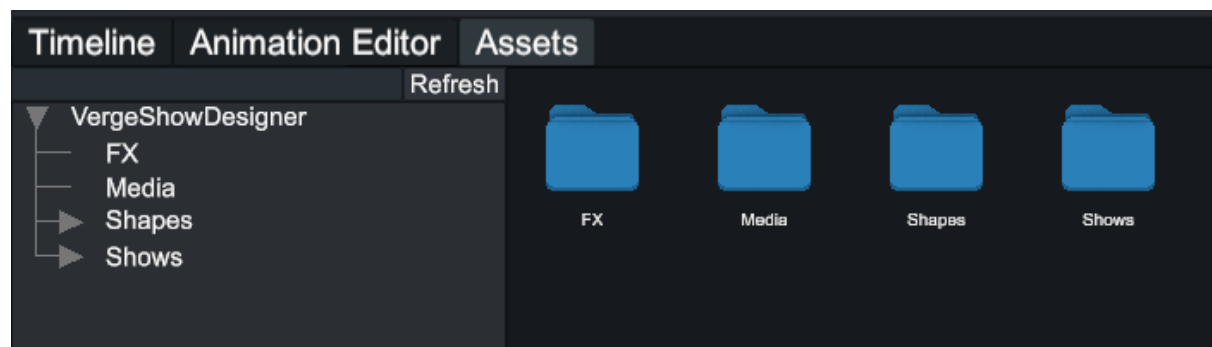
To add audio to the show file navigate to *Create > Audio > Audio Source*. With the Scene Speaker object selected click the Add Layer button and select *Audio Layer*. Right click on the Audio Layer and insert the desired audio file. Currently .wav is the only accepted file format.

Note: Audio files cannot be modified once in the software, they will be imported at their full length. Full files can be moved along the timeline freely but cannot be cropped or cut into pieces.

## Assets Tab

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Within the Assets Tab is the local folder layout for easy import of custom shapes and Vfabs. The VergeShowDesigner folder is found locally in the user's Documents folder. It has preset folders designed for simple file organization within the software.



Assets Tab displaying the VergeShowDesigner folder layout.

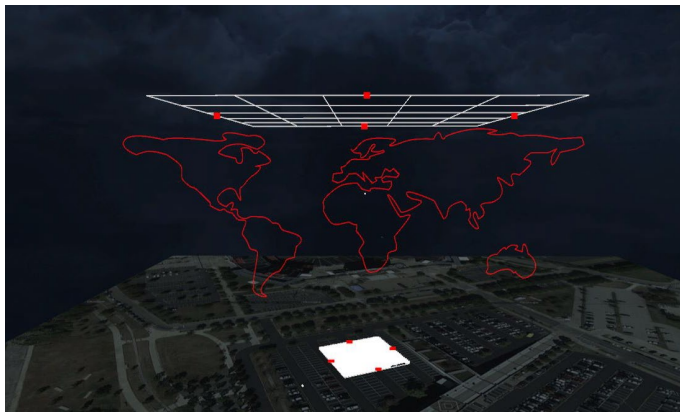
<b>FX</b>	Designated for prefab sequences (Vfabs).
<b>Media</b>	Where all renders automatically export to.
<b>Shapes</b>	Designated for user-made shapes, designs, and logos.
<b>Shows</b>	Where all show files are saved automatically.

# Show Design: Best Practices

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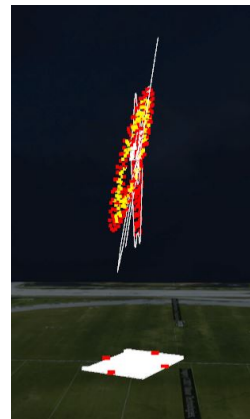
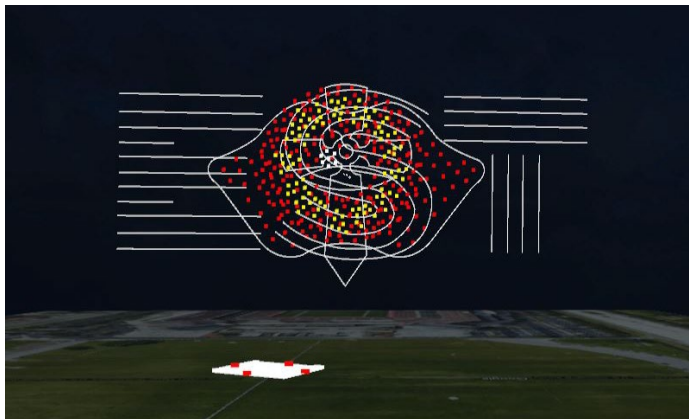
Below is a brief list of things the Verge team has learned that might help you avoid some speedbumps while getting used to the studio.

**Insert height grids into the scene for reference.** When working in a 3D software it can be hard to gauge the size of your formations. We've found it extremely helpful to use grids (*Create > Shape > 2D > Grid*) to lay out our general flight volume. At a minimum we add a grid parallel to the ground at 124 meters high - representing the FAA altitude limit of 400 feet.



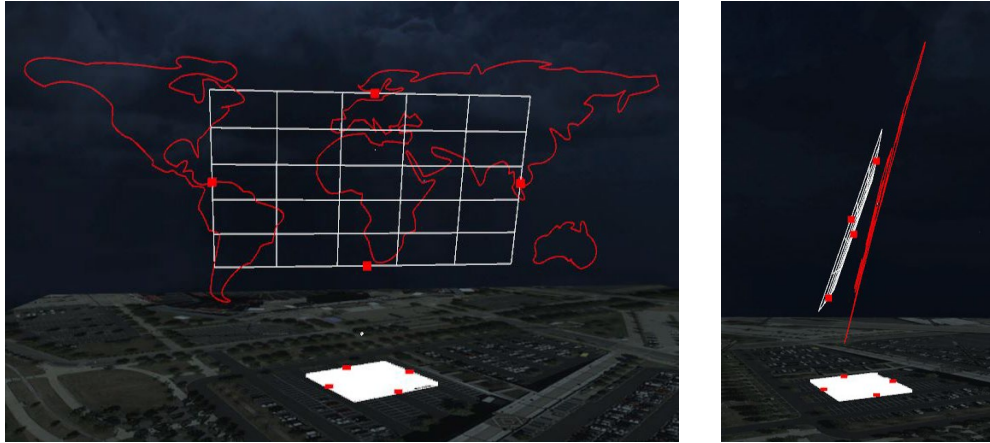
Sample content displaying height grid at 400 feet.

**Stack formations for faster transitions.** Show design using the Verge Studio is built on repetitive join and track events, meaning there will be many transitions throughout your show from one formation to another. To make these transitions as quick as possible and keep your audience engaged it is advantageous to place your objects directly on top of each other in the scene, minimizing the distance the drones are required to go to transition from one to the next.



Sample content front and side views displaying content stacking.

**Add overflow grids for faster transitions.** Some formations in your show will not require every drone in the swarm. When this is the case you want the drones that are not being used to be set up to transition to their next formation as quickly as possible. We accomplish this by adding a grid with no lighting behind the illuminated drones to hold any that are not being used. This grid is added as an extra formation element. We call this an overflow grid.



Sample content front and side views displaying an overflow grid.

**Angle content towards the ground.** Generally, audiences will be watching your show from the ground, and will be able to see your designs more clearly if they are rotated a few degrees downward. We find 10-15 degrees to be sufficient. Additionally, if a drone auto-lands during a show for any reason it will descend straight down - having the content on an angle minimizes the chance of a collision with another drone. You can see the slight angle in the overflow grid pictures.

**Using the color black.** Drones assigned the color black will have their light turned off. You can use this strategically for dramatic effect.